Soil Study for Proposed Golf Maintenance Facility,
Area "A", Wright-Patterson Air Force Base, Ohio

For

Setter, Leach & Lindstrom
1100 Peavey Building
730 Second Avenue South
Minneapolis, Minnesota 55402

Report No. 127776-0403-088

April 15, 2003

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937-236-8805
937-233-2016 FAX
www.bowser-morner.com

April 15, 2003

Setter, Leach & Lindstrom
1100 Peavey Building
730 Second Avenue South
Minneapolis, Minnesota 55402

Attention: Ms. Debra Young

Re: Report No. 127776-0403-088; Soil Study for Proposed Golf Maintenance Facility, Area "A", Wright-Patterson Air Force Base, Ohio

Dear Ms. Young:

Bowser-Morner is pleased to submit our report of the soil study for the above-referenced project. The purpose of the study was to determine the physical characteristics of the soil strata and allowable bearing capacity for the proposed golf maintenance buildings. Also noted are other conditions that could affect the design and/or construction of the buildings.

The samples collected that were not used to perform the laboratory tests will be kept in our laboratory for 30 days unless you advise us otherwise. If you have any questions or if we can help you in any way on this project or future work, please call us.

Sincerely,

BOWSER-MORNER ASSOCIATES, INC.

Jimmy Zhong

Jimmy Zhong, M.S., E.I.T.
Geotechnical Engineer

STATE OF OHIO
RICHARD J.Y. TSENG
43351
REGISTERED
PROFESSIONAL ENGINEER

Richard J.Y. Tseng, Ph.D., P.E.
Vice President
Chief Geotechnical Engineer

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SECTION I

TEXT

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1.0 INTRODUCTION

A golf maintenance facility will be constructed at the intersection of Skeel and San Antonio Avenues in Area "A" of Wright-Patterson Air Force Base (WPAFB), Ohio. A vicinity map (Figure 1) is included in Section III of this report. Our findings on the soil conditions and groundwater levels with respect to the potential construction problems, and recommendations for the allowable bearing capacity for the construction of the proposed buildings are given in the report.

Authorization to proceed with this soil study was given on February 26, 2003 by Ms. Debra Young of Setter, Leach & Lindstrom. The work was to proceed in accordance with our proposal and agreement, Quotation No. 02-2771-146 dated October 28, 2002.

The draft soil boring logs and our preliminary foundation recommendations were faxed to Ms. Debra Young and Mr. Steve Nordin of Setter, Leach & Lindstrom on March 27, 2003.

2.0 WORK PERFORMED

2.1 FIELD WORK

Four borings were made at the locations specified and staked by the client, as shown on the boring location plan, Figure 2 in Section III. The boring logs are included in Section III. The borings were made with a truck-mounted boring rig using hollow-stem augers and standard penetration resistance methods. The standard penetration tests were performed in accordance with ASTM D1586, which includes a 140-pound hammer, 30-inch drops, and two-inch-O.D. split-spoon samplers driven at maximum depth intervals of five feet or at major changes in stratum, whichever occurred first. The disturbed split-spoon samples were visually classified, logged, sealed in moisture-proof jars, and taken to the Bowser-Morner laboratory for study. The depths where these "A"-type split-spoon samples were collected are noted on the corresponding boring logs.

2.2 LABORATORY WORK

One Atterberg limits test was performed in accordance with ASTM D4318 to determine the liquid and plastic limits on the most visibly plastic, cohesive soil or as needed for soil classification. In addition, 13 moisture content determinations were made in accordance with ASTM D2216. The moisture contents ranged from 20.0% to 23.8% for the brown fat clay with sand; from 11.5% to 12.5% for the brown, sandy lean clay; and from 3.9% to 16.5% for the brown sand. The results of the laboratory tests are summarized in Table 2-1 and included in Section III of this report.

TABLE 2-1. Summary of Laboratory Test Results

Boring No.	Depth (ft.)	Moisture Content (%)	Atterberg Limits LL	PL	PI
1	6.0 – 7.5	13.0			
	8.5 – 10.0	7.0			
	13.5 – 15.0	5.7			
2	1.0 – 2.5	20.0	50	20	30
	6.0 – 7.5	9.9			
	8.5 – 10.0	3.9			
3	1.0 – 2.5	23.6			
	3.5 – 5.0	11.5			
	6.0 – 7.5	10.2			
4	1.0 – 2.5	23.8			
	3.5 – 5.0	12.2			
	6.0 – 7.5	12.5			
	8.5 – 10.0	16.5			

3.0 SOIL AND GROUNDWATER CONDITIONS

Based on information from the four borings made for this study, the subgrade soil conditions are described in descending order below:

- About six inches of topsoil.
- Below the topsoil layer, 3.0 feet of medium-stiff, brown fat clay with sand.
- Below the brown lean clay with sand layer, 2.5 to 5.0 feet of medium-stiff-to-stiff, brown, sandy lean clay.
- Below the brown, sandy, lean clay layer, 5.0 to 7.5 feet of medium-dense brown sand.

- Below the brown sand layer, medium-dense-to-dense brown sand with gravel extending to the bottoms of the borings at a depth of 15.0 feet.

Groundwater was not encountered during the boring operations. Free groundwater is defined as water that seeps into an open borehole before it is backfilled. Groundwater observations were made during the boring operations by noting the depth of water on the boring tools and in the open boreholes following withdrawal of the boring augers. However, it should be noted that short-term water level readings are not necessarily a reliable indication of the groundwater level and that significant fluctuations may occur due to variations in rainfall and other factors. For specific questions on the soil conditions, please refer to the individual boring logs in Section III.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 PROJECT DESCRIPTION

A golf maintenance facility will be constructed on the east side of the intersection of Skeel and San Antonio Avenues in Area "A" of Wright-Patterson Air Force Base, Ohio. These buildings will be single-story, pre-engineered, metal structures. One of the buildings will be about 80 feet wide and 148 feet long while the other will be 40 feet wide and 58 feet long. No specific building design or loading information was provided for this report. A four-foot-high, cast-in-place, concrete retaining wall will be constructed on the north side of the proposed buildings.

The following recommendations are based on this information. If the above statements are incorrect or changes are made, Bowser-Morner should be notified so that the new data can be reviewed and additional recommendations and services can be given if required to meet the needs of your project.

4.2 FOUNDATION RECOMMENDATIONS

4.2.1 FOUNDATION SUBGRADE PREPARATION

The proposed building sites are covered by topsoil and weak soil layers that extend to the approximate depths and elevations outlined in Table 4-1. The top elevations of the borings are interpreted from the site topography provided by the client.

Table 4-1. Depths and Elevations to the Bottom of Unreliable Soils

Boring No.	Depth to Bottom of Unreliable Soil (ft)	Elevation at Bottom of Unreliable Soil (ft)	Topsoil, Fill, and/or Weak Soil
1	3.5	815.9	Topsoil and Weak Soil
2	6.0	817.5	Topsoil and Weak Soil
3	3.5	818.4	Topsoil and Weak Soil
4	5.0	818.0	Topsoil and Weak Soil

The topsoil is unreliable to support the building foundations, floor slabs on-grade, and pavement, and should be removed and wasted. The weak soil is unreliable to support the building foundations. Most of the weak soil is the fat clay, which will shrink and swell depending on its moisture content. The fat clay can be removed and replaced with compacted fill, or treated with lime to improve the soil behavior. After the topsoil is removed, the weak soil within the building construction limits should be removed to the depths and elevations outlined in Table 4-1. The excavation within the construction limits should extend to suitable soils. The base of the excavation should also extend one lateral foot for every foot of excavation below the bottom of the footing foundation as shown in Figure 3 in Section III.

After the topsoil and weak soil have been removed from the building area, the top foot of the exposed ground surface should be compacted to 90% of the maximum dry unit weight as defined by the modified Proctor test (ASTM D1557) before any new fill or foundation is placed. Any soft soil pockets should be undercut and replaced with compacted fill. The lean clay or sandy, lean clay soils encountered on the site probably will have significantly different Proctor values. Consequently, samples to be tested by the Proctor method should be obtained from a representative area and from the same elevation as the design building subgrade.

After the bottom of the excavation has been compacted, structural fill can be placed to bring the building pad to the desired grade. Structural fill should be placed in accordance with the recommendations given in Section 4.4. The soil removed from this site that is free of organic or objectionable materials as defined by a field technician who is qualified in soil material identification and compaction procedures can be reused as fill for the building pad. Objectionable or undesirable soils are defined as those materials that cannot meet design placement specifications or materials that will deteriorate with time. It should be noted that lean clay or sandy, lean clay soils may require reworking to adjust the moisture content to meet the compaction criteria.

4.2.2 BUILDING FOUNDATION BEARING CAPACITY/SETTLEMENT

Based on the standard penetration test results from the four borings performed for this study, spread-footing foundations can be supported on the brown, sandy lean clay or on compacted fill prepared in accordance with the foundation subgrade preparation recommendations given in Section 4.2.1. Spread-footing foundations supported on the materials indicated above can be designed based on the following parameters:

- **Allowable bearing capacity:** 3,000 pounds per square foot (psf)
- **Minimum footing dimension:** 18 inches
- **Estimated Settlement:**
  Total: Less than one inch
  Differential: Less than 3/4 inch over a distance of 50 feet

For a higher bearing capacity, the foundation excavations should extend at least to the depths and the elevations outlined in Table 4-2 and should be supported on the brown sand layer and/or on the brown, sandy, lean clay layer.

Table 4-2. Depths and Elevations to Bearing Strata

Boring No.	Depth to Bearing Strata (ft)	Elevation of Bearing Strata (ft)
1	8.5	810.9
2	8.5	815.0
3	8.5	813.4
4	6.0	817.0

After the excavation extends to the desired grade, the exposed ground surface should be compacted to 90% of the maximum dry unit weight as defined by the modified Proctor test (ASTM D1557). The footing foundations can be supported on the brown sand; on the brown, sandy lean clay; or on compacted fill. The compacted fill should be placed in accordance with the recommendations given in Section 4.4. The spread-footing foundations that extend to the depths outlined in Table 4-2 can be designed with an allowable bearing capacity of 4,000 psf.

The allowable bearing capacity recommended above can be increased by a factor of one-third when designing for live loads such as wind or earthquake loading. When determining the geometric size (the "footprint") of the footing foundation, the total building system loads applied to the tops of the foundations should be considered in the bearing pressure calculations.

The bearing capacity recommended above for foundations supported on structural fill applies to well-graded granular soils, low-to-medium plastic clays, clayey sands, and some silty sands that are placed and compacted in accordance with the recommendations given in this report. However, uniformly graded or gap-graded granular soils (GP or SP), silts (ML), silty fine sands (SM), and high plasticity clays (CH) will be difficult to place and compact, and may result in a reduced bearing capacity. If these soils will be used as backfill, Bowser-Morner should be notified before the soils are placed so that the proposed placement methods and bearing capacity recommendations can be reviewed.

The bearing capacity of a soil is not a unique physical property of the soil. Instead, it depends explicitly on several factors including the footing type, size, and shape; the depth of embedment; the eccentricity and inclination of the applied load; the footing base inclination; the stiffness of the footing; the proximity of the footing to open cuts or slopes; the relative distance between the bottom of the footing and the water table; and the allowable amounts of settlement. The recommended allowable bearing capacity is based on the foundation design parameters given above and the assumptions that the applied load is vertical with no eccentricity, the base is horizontal and level, the footing is rigid, the footing is not close to an open cut or slope, and the water table is below the bottom of footing. If the actual conditions vary from the parameters and assumptions stated above, Bowser-Morner should be notified so that the new information can be reviewed and additional recommendations and services can be given to meet the needs of your project.

The bottoms of exterior footing foundations should be at least 36 inches below the final adjacent grades to protect against frost penetration and heaving. Interior footings not subject to frost action may bear at a minimum depth of 18 inches below the floor slab if they are supported on original materials or compacted fill placed in accordance with our recommendations.

Foundations supported on soil settle as the result of externally applied loads. While the building foundations should be expected to settle, the amount of settlement should be within the tolerable limits for the structures.

4.2.3 SOIL PARAMETERS FOR RETAINING WALL DESIGN

The soil conditions for the proposed retaining wall are indicated in Boring 3 made for this study. We assume that the retaining wall will be backfilled with free-draining granular material, with no water allowed to accumulate behind the wall. The "at rest" lateral earth pressure coefficient is 0.5 while the active and passive lateral earth pressure coefficients are 0.3 and 3.3, respectively. The determination of the lateral earth pressure coefficients are based on the strength parameter "ϕ" of 30°. Based on the unit weight of soil at 125 pounds per cubic foot, the "at rest" lateral earth pressure is 63 pounds per square foot per foot (psf per foot) depth, the active lateral earth pressure is 37.5 psf per foot depth, and the passive lateral pressure is 412 psf per foot depth. For foundations supported on compacted granular backfill, the friction angle "ϕ" between the bottoms of the foundation and the top of the granular backfill layer can be designed with a value of 35°. If the foundation will be placed over the brown, lean clay layer, a friction angle "ϕ" of 20° is recommended. The allowable bearing capacity for the retaining-wall footing foundations placed 3.5 feet below the existing grade is 3,000 pounds per square foot. The retaining wall design is beyond the scope of this study.

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4.2.4 SITE CLASSIFICATION OF SEISMIC DESIGN

Based on the results of the standard penetration tests (SPT) in Boring 1, which extended to a depth of 15 feet, the average "N" value is approximately 16 blows per foot for the soil layer within 15 feet of the existing grade. Based on the "Groundwater Resource Map for Greene County" prepared by the Ohio Department of Natural Resources, the bedrock in this area is more than 100 feet below the existing grade. Based on the results of the SPT, it is our opinion that the site will be classified as a "D" type in accordance with the *Ohio Building Code.*

4.3 SLABS ON-GRADE

The topsoil and the fat clay are not reliable to support the floor slab due to the potential for settlement. We recommend that the unreliable soils be removed from beneath the floor slab areas and that the exposed ground surface be compacted as outlined above for the foundations. The floor slabs on-grade can be supported on compacted fill placed in accordance with the recommendations given in Section 4.4. We recommend that the upper four to six inches of compacted fill be a well-graded, angular, granular material such as crushed sand and gravel or crushed stone. To help distribute concentrated loads and equalize moisture conditions under the slabs, this granular material should contain less than 5% of fines or particles that can pass through a No. 200 sieve.

Topsoil, fill, and/or other deleterious materials encountered during the site preparation must be removed and replaced with select engineered fill that is compacted to the specifications outlined in Section 4.4 of this report.

We recommend that slabs on-grade "float" by being fully supported on the ground and not structurally connected to walls or foundations. Floating will minimize the possibility of cracking and displacement of the slabs on-grade as a result of differential movements between the slab and the foundations. Although the movements should be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

4.4 COMPACTION REQUIREMENTS

Structural fill placed below the foundation bearing elevation for the construction of the buildings should be compacted to at least 95% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by the modified Proctor test (ASTM D1557). Fill placed above the bottoms of the foundations or under pavement areas should be compacted to at least 90% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by the modified Proctor test (ASTM D1557). The compaction should be accomplished by placing the fill in successive, horizontal, approximately six- to eight-inch-thick loose lifts and mechanically compacting each lift to at least the specified minimum dry density. Field density tests should be performed at a minimum rate of one per 2500 square feet of fill area and for each lift to verify that adequate compaction is achieved. Backfill for utility trenches, foundation excavations, etc., within structures or paved areas, is considered structural fill and should be placed in accordance with these recommendations.

It must be emphasized that the excavation and compaction of soil fill are highly influenced by weather conditions. Performing the earthwork under wet and frozen conditions is generally very difficult. As a result, compaction of wet silty and clayey soil should be avoided during wet and frozen conditions because the wet soil cannot be compacted to the required unit weight without drying or other soil stabilization methods. Alternatively, granular soil can be used as backfill to facilitate the backfilling and compaction work during winter and wet weather. The construction cost during the winter and wet weather conditions will be higher due to the need to purchase the granular soil.

Puddling or jetting of the backfill material, including the utility trenches, should not be allowed as a compaction method. Silty or clayey soils encountered above foundation depth will often soften, and the bearing capacity may be reduced if water ponds in the excavation.

4.5 FOUNDATION EXCAVATIONS

During the foundation excavations, the subsurface conditions should be verified. Changes in subsurface conditions other than what are shown on the boring logs warrant additional subsurface investigation before the building foundations are constructed.

The foundation excavations should be observed to ensure that the loose, soft, or otherwise undesirable materials are removed and that the foundations will be supported directly on an acceptable surface. At the time of this observation, it may be necessary to use a hand penetration device in the base of the foundation excavation to ensure that the soils immediately below the foundation base are satisfactorily prepared to support the foundations. Please note that such shallow observations do not replace an adequate deep-boring program and structural fill compaction QA/QC records. The overall performance of the foundations is governed by the soils below the bottom of the footing foundation.

If pockets of soft, loose, or otherwise unsuitable materials are encountered in the footing excavations and it is inconvenient to lower the footings, the proposed footing elevations may be reestablished by backfilling after the undesirable materials have been removed. The excavation under each footing should extend to suitable soils, and the base of the excavation should extend one lateral foot for every foot of excavation below the bottom of the footing foundation as shown in Figure 3 in Section III. The entire excavation should then be refilled with well-compacted, engineered fill. Special care should be taken to remove the sloughed, loose, or soft materials near the base of the excavation slopes. Extra care should also be taken to tie-in the compacted fill with the excavation slopes, with benches as necessary, to ensure that no pockets of loose or soft materials are left along the excavation slopes below the foundation bearing level. The contractor should maintain temporary cut slopes in accordance with the current OSHA regulations governing trenching and slope stability.

Soils exposed at the bases of satisfactory foundation excavations should be protected against any detrimental change in condition such as from construction disturbances, rain, and freezing. Surface runoff should be drained away from the excavation and not allowed to pond. If possible, foundation concrete should be placed the same day the excavation is made. If this is not practical, the foundation excavations should be adequately protected. Also, for this reason, proper drainage should be maintained after construction. It must be emphasized that all excavations must conform to all state, federal, and local regulations relative to slope geometry.

4.6 CONSTRUCTION DEWATERING

At the time of our study, no free groundwater was encountered during the boring operations. We do not anticipate that significant groundwater seepage will be encountered in the foundation excavations. However, it is likely that seepage and surface water infiltration into foundation excavations will occur, depending on the seasonal conditions. Any seepage in the excavations can be intercepted by open sumps from which the water can be pumped. However, care must be exercised when pumping from sumps that extend into silts or other granular soils since general deterioration of the bearing soils and a localized "quick" condition could result. If significant groundwater influxes are noted within the excavations, other dewatering techniques should be determined at the time of construction.

The amount and type of dewatering required during construction will depend on the weather and groundwater levels at the time of construction, and the effectiveness of the contractor's techniques in preventing surface runoff from entering open excavations. Typically, groundwater levels are highest during winter and spring, and lower in summer and early fall.

4.7 DRAINAGE

Adequate drainage should be provided at the site to minimize any increase in moisture content of the foundation soils during and after construction. The exterior grade including all pavements or parking areas should be sloped away from the new building foundations to keep water from ponding. All permanent foundation, wall, and below-grade floor drains should provide positive discharge away from the buildings.

5.0 CLOSURE

5.1 BASIS OF RECOMMENDATIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions. Data used during this exploration included, but were not necessarily limited to:

- Four exploratory borings performed during this study.
- Observations of the project site by our staff.
- The results of the laboratory soil tests.
- The site plan provided by Setter, Leach & Lindstrom and HLS Surveyors and Engineers.
- Limited interaction with Ms. Debra Young and Mr. Steve Nordin of Setter, Leach & Lindstrom, Mr. Bob Bank, the corrosion engineer, Mr. David Reynolds of HLS Surveyors and Engineers; and Mr. Gwen Hampton and Mr. Richard Boehm with WPAFB.
- Published soil or geologic data of this area.

In the event that changes in the project characteristics are planned, or if additional information or differences from the conditions anticipated in this report become apparent, Bowser-Morner should be notified so that the conclusions and recommendations contained in this report can be reviewed and, if necessary, modified or verified in writing.

5.2 LIMITATIONS AND ADDITIONAL SERVICES

The subsurface conditions discussed in this report and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by designers, or that the construction process has altered the soil conditions. As variations in the soil profile are encountered, additional subsurface sampling and testing may be necessary to provide data required to reevaluate the recommendations of this report. Consequently, after submission of this report, it is recommended that Bowser-Morner be authorized to perform additional services to work with the designer(s) to minimize errors and omissions regarding the interpretation and implementation of this report.

Before construction begins, we recommend that Bowser-Morner:

- Work with the designers to implement the recommended geotechnical design parameters into plans and specifications.
- Consult with the design team regarding interpretation of this report.
- Establish criteria for the construction observation and testing for the soil conditions encountered at this site.
- Review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that Bowser-Morner:

- Observe the construction, particularly the site preparation, fill placement, and foundation excavation or installation.
- Perform in-place density testing of all compacted fill.
- Perform materials testing of soil and other materials as required.
- Consult with the design team to make design changes in the event that differing subsurface conditions are encountered.

If Bowser-Morner is not retained for these services, we shall assume no responsibility for construction compliance with the design concepts, specifications or recommendations.

5.3 WARRANTY

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, express or implied, is made.

The scope of this study did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, within or beyond the site studied. Any statements in the report or on the boring logs regarding odors, staining of soils or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and sampling, including groundwater sampling, may be required. Bowser-Morner can provide this service and would be pleased to provide a cost proposal to perform such a study, if requested.

This report has been prepared for the exclusive use of Setter, Leach & Lindstrom for specific application to the golf maintenance facility in Area "A" of Wright-Patterson Air Force Base, Ohio (see Figure 1 in Section III of this report). Specific design and construction recommendations have been provided in the various sections of the report. The report shall therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. Bowser-Morner is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

SECTION II

SPECIFICATIONS

CLEARING AND GRADING SPECIFICATIONS

I. GENERAL CONDITIONS

The contractor shall furnish all labor, materials, and equipment, and perform all work and services necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction and grading as shown on the plans and as described therein.

This work shall consist of all clearing and grading, removal of existing structures unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications.

This work is to be accomplished under the constant and continuous supervision of the Owner or his designated representative.

In these specifications the terms "approved" and "as directed" shall refer to directions to the Contractor from the Owner or his designated representative.

II. SUBSURFACE CONDITIONS

Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including, without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site; and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work. Borings and/or soil investigations shall have been made. Results of these borings and studies will be made available by the Owner to the Contractor upon his request, but the Owner is not responsible for any interpretations or conclusions with respect thereto made by the Contractor on the basis of such information, and the Owner further has no responsibility for the accuracy of the borings and the soil investigations.

If conditions other than those indicated are discovered by the Contractor, the Owner should be notified immediately. The material which the Contractor believes to be a changed condition should not be disturbed so that the Owner can investigate the condition.

III. SITE PREPARATION

Within the specified areas, all trees, brush, stumps, logs, tree roots, and structures scheduled for demolition shall be removed and disposed of.

All cut and fill areas shall be properly stripped. Topsoil will be removed to its full depth and stockpiled for use in finish grading. Any rubbish, organic and other objectionable soils, and other deleterious material, shall be disposed of off the site, or as directed by the Owner or his designated representative if on site disposal is provided. In no case shall such objectionable material be allowed in or under the fill unless specifically authorized in writing.

Prior to the addition of fill, the original ground shall be compacted to job specifications as outlined below. Special notice shall be given to the proposed fill area at this time. If wet spots, spongy conditions, or ground water seepage is found, corrective measures must be taken before the placement of fill.

IV. FORMATION OF FILL AREAS

Fills shall be formed of satisfactory materials placed in successive horizontal layers of not more than eight (8) inches in loose depth for the full width of the cross section. The depth of lift may be increased if the Contractor can demonstrate the ability to compact a larger lift. If compaction is accomplished using hand-tamping equipment, lifts will be limited to 4-inch lose lifts.

All material entering the fill shall be free of organic matter such as leaves, grass, roots, and other objectionable material.

The operations on earth work shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions. The Contractor shall keep the work areas graded to provide the drainage at all times.

The fill material shall be of the proper moisture content before compaction efforts are started. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. The moisture content of the fill material should be no more than two (2) percentage points higher or lower than optimum unless otherwise authorized. Sprinkling shall be done with equipment that will satisfactorily distribute the water over the disced area.

Compaction operations shall be continued until the fill is compacted to not less than 90% above foundation elevation and 95% below foundation elevation, of the maximum density as determined in accordance with ASTM D-1557-91 (Modified). Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers. The equipment shall be operated in such a manner that hardpan, cemented gravel, clay or other chunky soil material will be broken up into small particles and become incorporated with the other material in the layer.

In the construction of filled areas, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, additional layers shall be constructed in horizontal planes. If directed, original slopes shall be continuously, vertically benched to provide horizontal fill planes. The size of the benches shall be formed so that the base of the bench is horizontal and the back of the bench is vertical. As many benches as are necessary to bring the site to final grade shall be constructed. Filling operations shall begin on the lowest bench, with the fill being placed in horizontal eight (8) inch loose lifts unless otherwise authorized. The filling shall progress in this manner until the entire first bench has been filled, before any fill is placed on the succeeding benches. Proper drainage shall be maintained at all times during benching and filling of the benches, to insure that all water is drained away from the fill area.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portion of the areas. Stones or fragmentary rock larger than four (4) inches in their greatest dimensions will not be allowed in the fill unless specifically authorized in writing. Rock fill shall be brought up in layers as specified or as directed, and every effort shall be exerted to fill the voids with the finer material to form a dense, compact mass. Rock or boulders shall be disposed of as deleterious material per Item III.

Frozen material shall not be placed in the fill nor shall the fill be placed upon frozen material.

The Contractor shall be responsible for the stability of all fills made under the contract, and shall replace any portion, which in the opinion of the Owner or his designated representative, has become displaced due to carelessness or negligence on the part of the Contractor. Fill damaged by inclement weather shall be repaired at the Contractor's expense.

V. SLOPE RATIO AND STORM WATER RUN-OFF

Slopes shall not be greater than 2 (horizontal) to 1 (vertical) in both cut and fill, and storm water shall not be drained over the slopes.

VI. GRADING

The Contractor shall furnish, operate, and maintain such equipment as is necessary to construct uniform layers, and control smoothness of grade for maximum compaction and drainage.

VII. COMPACTING

The compaction equipment shall be approved equipment of such design, weight, and quantity to obtain the required density in accordance with these specifications.

VIII. TESTING AND INSPECTION SERVICES

Testing and inspection services will be provided by the Owner.

IX. SPECIAL CONDITIONS

SECTION III

BORING LOG TERMINOLOGY, BORING LOGS, LABORATORY DATA, AND PRINTS

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Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one—not even you—*should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject To Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations", many of these provisions indicate where geotechnical engineers responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Rely on Your Geotechnical Engineer for Additional Assistance

Membership in ASFE exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE

8811 Colesville Road Suite G106 Silver Spring, MD 20910
Telephone: 301-565-2733 Facsimile: 301-589-2017
email: info@asfe.org www.asfe.org

BORING LOG TERMINOLOGY

Stratum Depth:

Distance in feet and/or inches below ground surface.

Stratum Elevation:

Elevation in feet below ground surface elevation.

Description of Materials:

Major types of soil material existing at boring location. Soil classification based on one of the following systems: Unified Soil Classification System., Ohio State Highway Classification System, Highway Research Board Classification System, Federal Aviation Authority Classification System, Visual Classification.

Sample No.:

Sample numbers are designated consecutively, increasing with depth for each boring.

Sample Type:

"A" Split spoon, 2" O.D., 1-3/8" I.D., 18" in length.

"B" Rock Core

"C" Shelby Tube 3" O.D. except where noted

"D" Soil Probe

"E" Auger Cuttings

"F" Sonic

Sample Depth:

Depth below top of ground at which appropriate sample was taken.

Blows per 6" on Sampler:

The number of blows required to drive a 2" O.D., 1-3/8" I.D., split spoon sampler, using a 140 pound hammer with a 30-inch free fall, is recorded for 6" drive increments. (Example: 3/8/9).

"N" Blows/Ft.:

Standard penetration resistance. This value is based on the total number of blows required for the last 12" of penetration. (Example: 3/8/9: N = 8 + 9 = 17)

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Water Observations:

Depth of water recorded in test boring is measured from top of ground to top of water level. Initial depth indicates water level during boring, completion depth indicates water level immediately after boring, and depth after "X" number hours indicates water level after letting water rise or fall over a time period. Water observations in pervious soil are considered reliable ground water levels for that date. Water observations in impervious soils can not be considered accurate ground water measurements for that date unless records are made over several days' time. Factors such as weather, soil porosity, etc., will cause the ground water level to fluctuate for both pervious and impervious soils.

SOIL DESCRIPTION

Color:

When the color of the soil is uniform throughout, the color recorded will be such as brown, gray, or black and may be modified by adjectives such as light and dark. If the soil's predominant color is shaded by a secondary color, the secondary color precedes the primary color, such as: gray-brown, yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled, such as: mottled brown and gray.

Particle Size		Visual
Boulders		Larger than 8"
Cobbles		8" to 3"
Gravel	– Coarse	3" to 3/4"
	– Fine	2 mm. To 3/4"
Sand	– Coarse	2 mm. – 0.6 mm. (Pencil lead size)
	– Medium	0.6 mm. – 0.2mm. Table sugar and salt size)
	– Fine	0.2 mm. – 0.06 mm. (Powdered sugar and human hair size)
Silt		0.06 mm. – 0.002 mm.
Clay		0.002 and smaller (Particle size of both Silt and Clay not visible To naked eye

Soil Components

Major Component:	Minor Component Term
Gravel	Trace 1-10%
Sand	Some 11-35%
Silt	And 36-50%
Clay	

Moisture Content

Term	Relative Moisture
Dry	Powdery
Damp	Moisture content below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content Above liquid limit

Condition of Soil Relative to Compactness Granular Material

Very Loose	5 blows/ft. or less
Loose	6 to 10 blows/ft.
Medium Dense	11 to 30 blows/ft.
Dense	30 to 50 blows/ft.
Very Dense	51 blows/ft. or more

Condition of Soil Relative to Consistency Cohesive Material

Very Soft	3 blows/ft. or less
Soft	4 to 5 blows/ft.
Medium Stiff	6 to 10 blows/ft.
Stiff	11 to 15 blows/ft.
Very stiff	16 to 30 blows/ft.
Hard	31 blows/ft. or more

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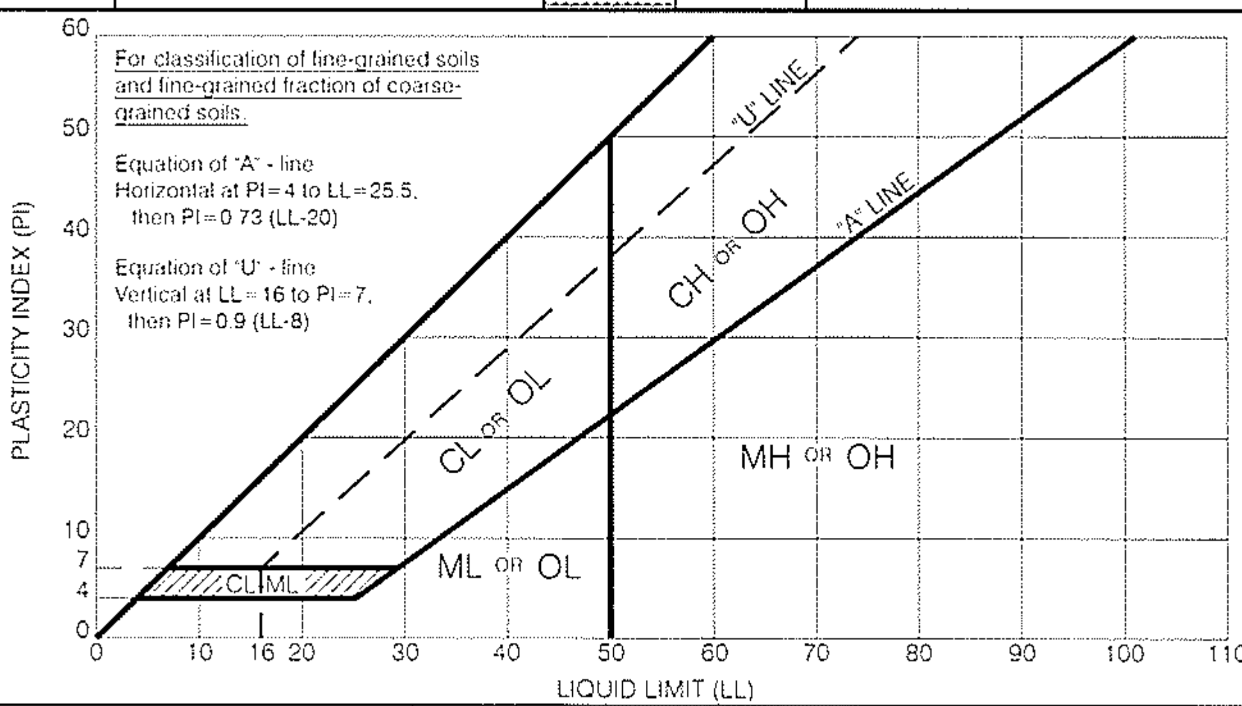
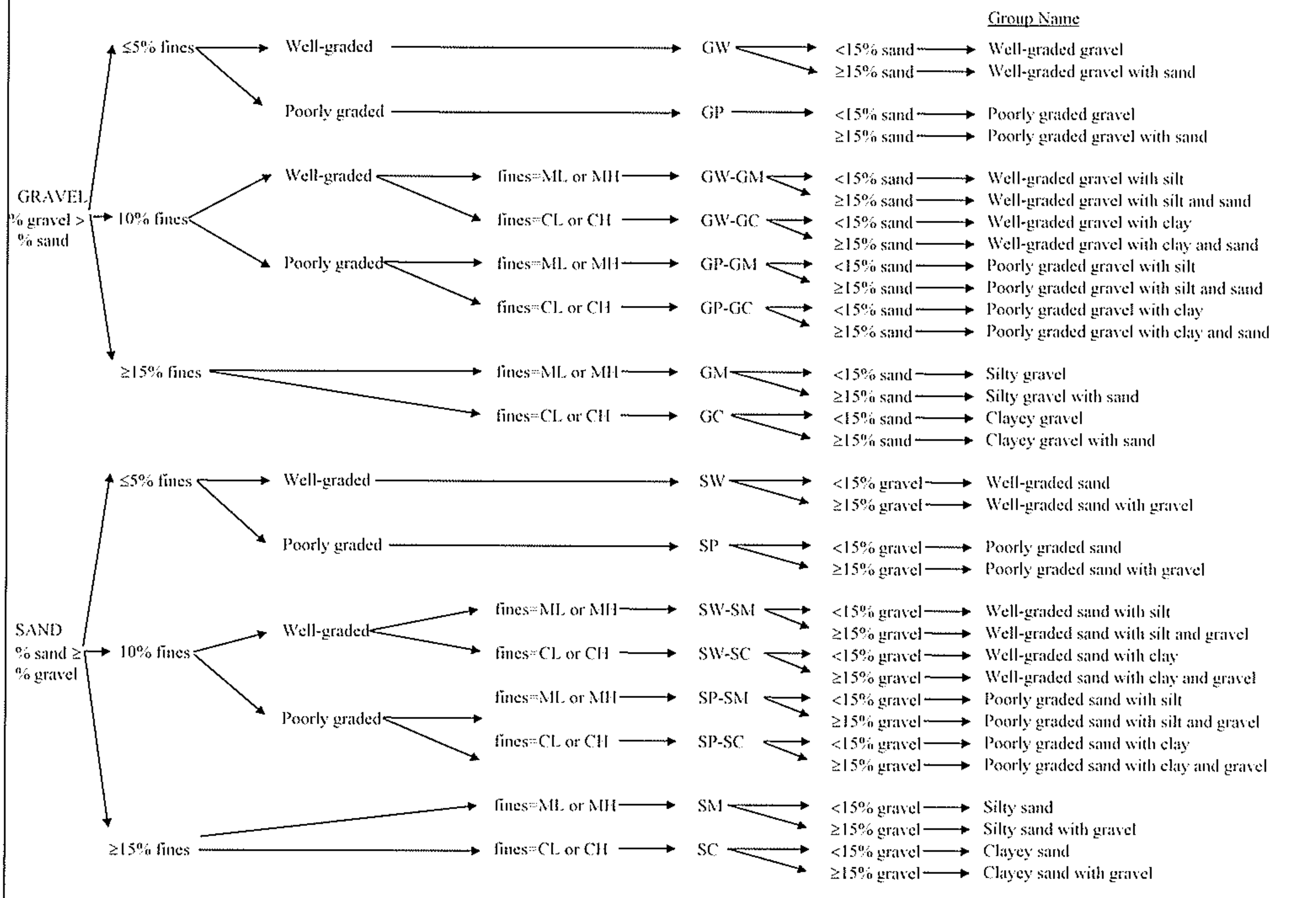
UNIFIED CLASSIFICATION SYSTEM

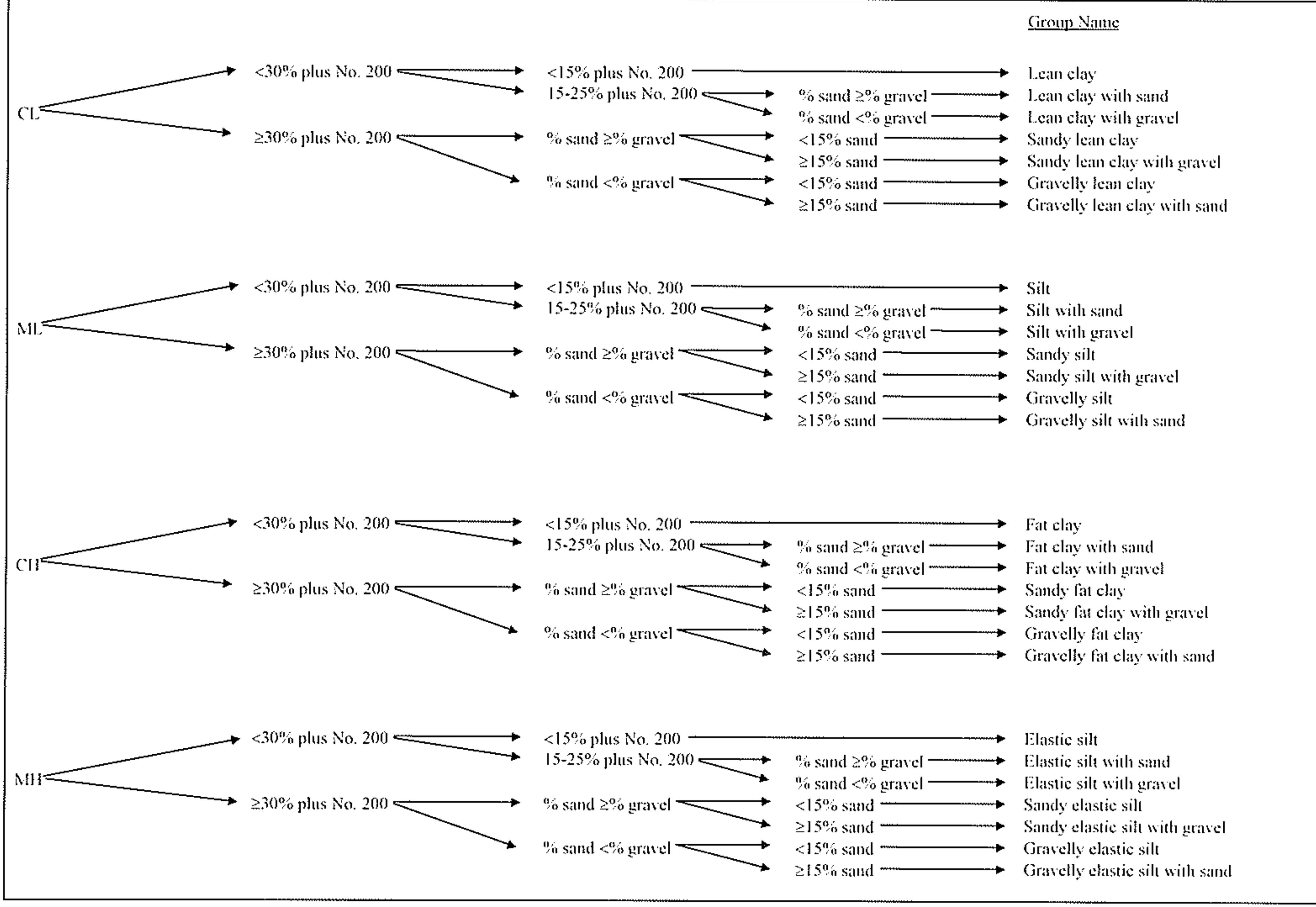
MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVEL WELL-GRADED GRAVEL WITH SAND
				GP	POORLY GRADED GRAVEL POORLY GRADED GRAVEL WITH SAND
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES APPRECIABLE AMT. OF FINES)		GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
				GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SAND WELL-GRADED SAND WITH GRAVEL
				SP	POORLY GRADED SAND POORLY GRADED SAND WITH GRAVEL
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMT. OF FINES)		SM	SILTY SAND SILTY SAND WITH GRAVEL
				SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILT AND CLAYS	LIQUID LIMIT <u>LESS</u> THAN 50		ML	SILT, SILT WITH SAND, SANDY SILT GRAVELLY SILT, GRAVELLY SILT WITH SAND
				CL	LEAN CLAY WITH SAND, SANDY LEAN CLAY GRAVELLY LEAN CLAY WITH SAND
				OL	ORGANIC CLAY, SANDY ORGANIC CLAY ORGANIC SILT, SANDY ORGANIC SILT WITH GRAVEL
	SILT AND CLAYS	LIQUID LIMIT <u>GREATER THAN 50</u>		MH	ELASTIC SILT WITH SAND, SANDY ELASTIC SILT GRAVELLY ELASTIC SILT WITH SAND
				CH	FAT CLAY WITH SAND, SANDY FAT CLAY GRAVELLY FAT CLAY WITH SAND
				OH	ORGANIC CLAY WITH SAND, SANDY ORGANIC CLAY, ORGANIC SILT, SANDY ORGANIC SILT
	HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS



Flow Chart for Visually Identifying Soils Based on ASTM D-2488



Flow Chart for Visually Identifying Soils Based on ASTM D-2488



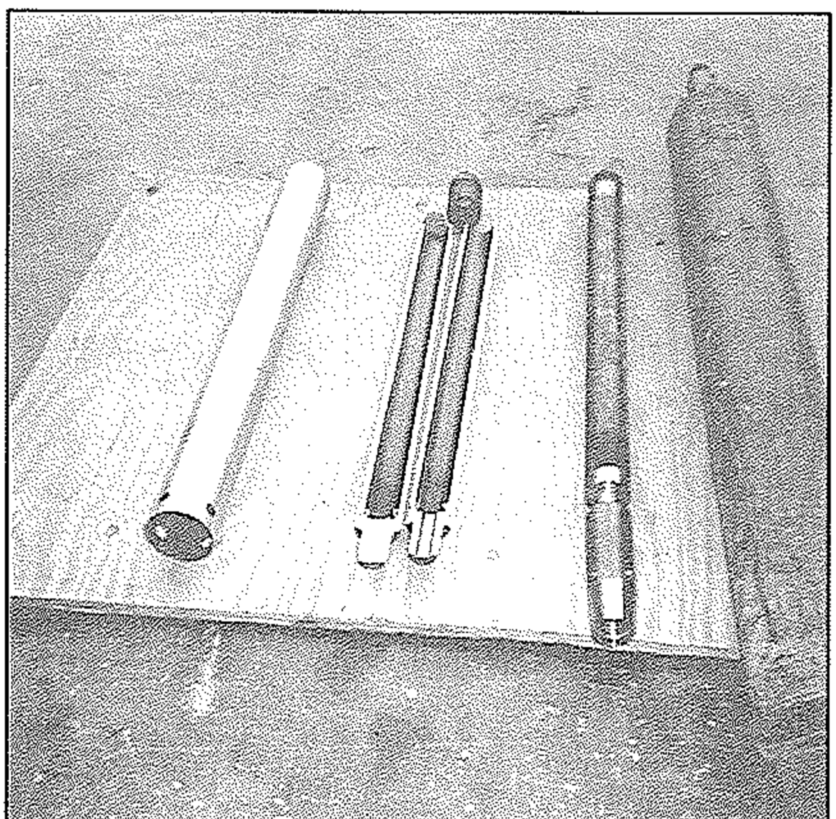
STANDARD PENETRATION RESISTANCE (ASTM D1586)

The purpose of this test is to determine the relative consistency of the soils in a boring, or from boring over the site. This method consists of making a hole in the ground and driving a 2-inch O.D. split spoon sampler into the soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6 inches of penetration. Values of standard penetration (N) are determined in blows per foot, summarizing the flows required for the last two 6-inche increments of penetration.

Example : 2-6-8; N = 14

THIN-WALLED SAMPLER (ASTM D1587)

The purpose of the thin-walled sampler is to recover a relatively undisturbed soil sample for laboratory tests. The sampler is a thin-walled seamless tube with a 3-inch outside diameter, which is hydraulically pressed into the ground, at a constant rate. The ends are then sealed to prevent soil moisture loss, and the tube is returned to the laboratory for tests.



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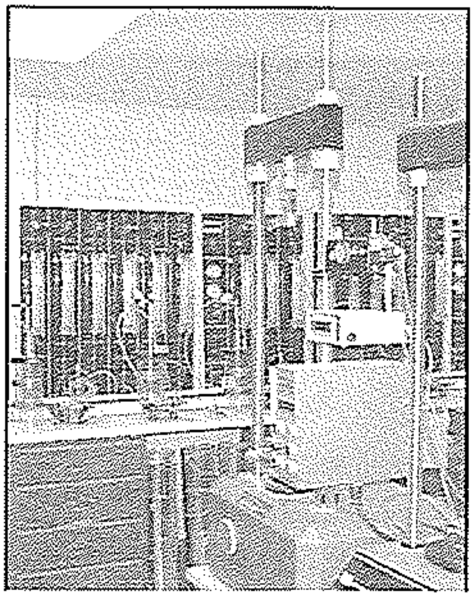
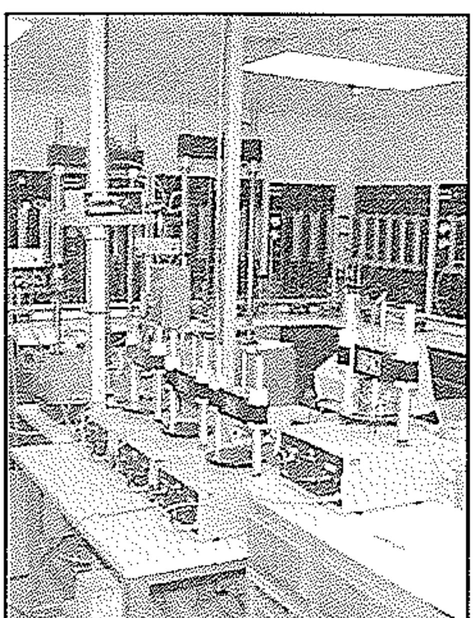
UNCONFINED COMPRESSION OR TRIAXIAL TESTS (ASTM D 2166)



The unconfined compression test and the triaxial tests are performed to determine the shearing strength of the soil, to use in establishing its safe bearing capacity. In order to perform the unconfined compression test, it is necessary that the soil exhibit sufficient cohesion to stand in an unsupported cylinder. These tests are normally performed on samples which are 6.0 inches in height and 2.85 inches in diameter. In the triaxial test, various lateral stresses can be applied to more closely simulate the actual field conditions. There are several different types of triaxial tests. These are, however, normally performed on constant strain apparatus with a deformation rate of 0.05 inches per minute.

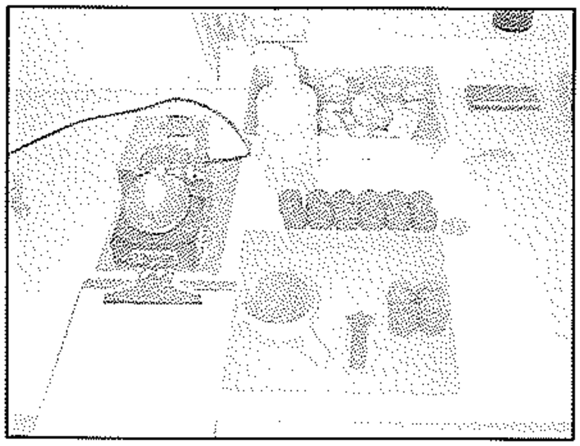
CONSOLIDATION TEST (ASTM D 2435)



The purpose of this test is to determine the compressibility of the soil. This test is performed on a sample of soil which is 2.5 inches in diameter and 1.0 inch in height, and has been trimmed from relatively "undisturbed" samples. The test is performed with a lever system or an air activated piston for applying load. The loads are applied in increments and allowed to remain on the sample for a period of 24 hours. The consolidation of the sample under each individual load is measured and a curve of void ratio vs. Pressure is obtained. From the information obtained in this manner and the column loads of the structure, it is possible to calculate the settlement of each individual building column. This information, together with the shearing strength of the soil, is used to determine the safe bearing capacity for a particular structure.

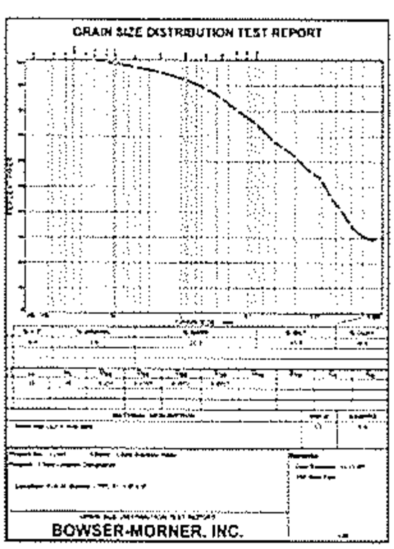
REVISED TO ASTM D4318
ATTERBERG LIMITS (ASTM D423 AND D424)

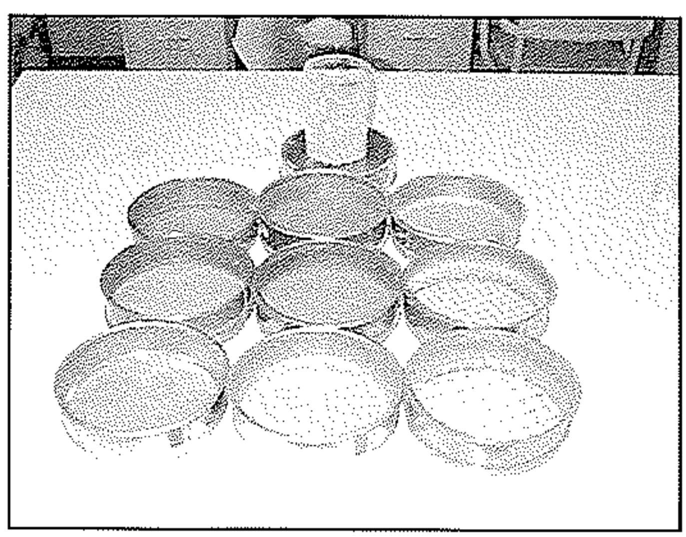
These tests determine the liquid and plastic limits of soils having a predominant percentage of fine particle (silt and clay) sizes. The liquid limit of a soil is the moisture content expressed as a percent at which the soil changes from a liquid to a plastic state, and the plastic limit is the moisture content at which the soil changes from a plastic to a semi-solid state. Their difference is defined as the plasticity index (P.I. = L.L. - P.L.), which is the change in moisture content required to change the soil from a "semi-solid" to a liquid. These tests furnish information about the soil properties which is important in determining their relative swelling potential and their classifications.



MECHANICAL ANALYSIS (ASTM D422)

This test determines the percent of each particle size of a soil. A sieve analysis is conducted on particle sizes greater than a No. 200 sieve (0.074 mm), and a hydrometer test on particles smaller than the No.200 sieve. The gradation curve is drawn through the points of cumulative percent of particle size, and plotted on semi-logarithmic paper for the combined sieve and hydrometer analysis. This test, together with the Atterberg Limits tests, is used to classify a soil.





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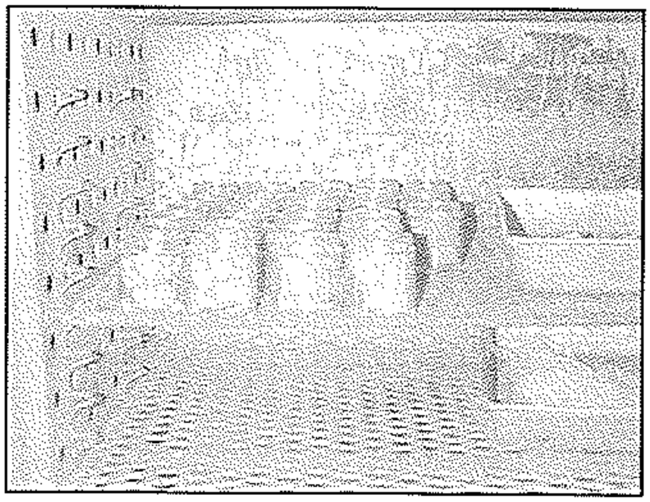
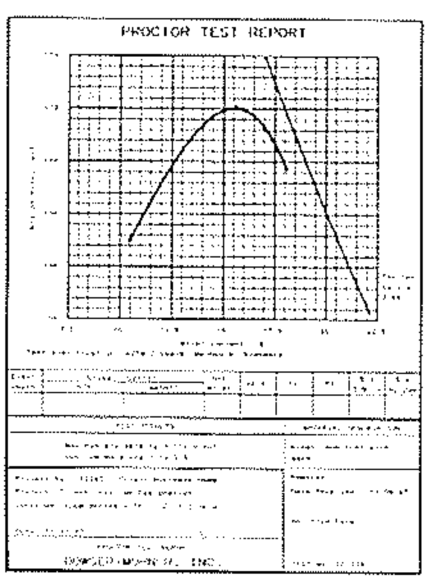
NATURAL MOISTURE CONTENT (ASTM D2216)

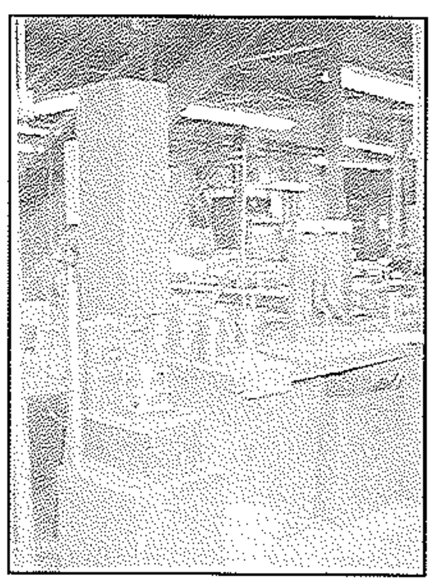
The purpose of this test is to indicate the range of moisture contents present in the soil. A wet sample is weighed, placed in the constant temperature oven at 105° for 24 hours, and re-weighed. The moisture content is the change in weight divided by the dry weight.



PROCTOR TESTS

The purpose of these tests is to determine the maximum density and optimum moisture content of a soil. The Modified Proctor test is performed in accordance with ASTM D1557-70. The test is performed by dropping a 10-pound hammer 25 times from an 18-inch height on each of 5 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 56,250 foot pounds per cubic foot. The moisture content is then raised, and this procedure is repeated. A moisture density curve is then plotted, with the density on the ordinate axis and the moisture on the abscissa axis. The moisture content at which the maximum density requirement can be achieved with a minimum compactive effort is designated as the optimum moisture content (O.M.C.). The Standard Proctor test is performed in accordance with ASTM D698-70. This test is similar to the Modified Proctor test and is performed by dropping a 5.5 pound hammer 25 times from a height of 12 inches on 3 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 12,375 foot pounds per cubic foot. This test gives proportionately lower results than the Modified Proctor test.





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CLIENT	JOB NO.		
SETTER, LEACH & LINDSTROM	127776		
PROJECT	BORING STARTED 3/19/03	BORING COMPLETED 3/19/03	**1** Boring No.
SOIL STUDY FOR PROPOSED GOLF MAINTENANCE FACILITY AREA "A", WPAFB, OHIO	DRILLER JA	METHOD 3 1/4" HSA	
	TYPED BY kmw		Sheet 1 of 1

PROJECT LOCATION
LAT. 39° 48' 22" LONG. 84° 02' 46"
SURFACE ELEVATION 819.4'
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS

N VALUE, blows/ft. ◇ 10 20 30 40 50 60 70 80 90

DEPTH	SAMPLE NO.	SAMPLER TYPE / RECOVERY	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE	REMARKS
0.0–0.5			TOPSOIL			
0.5–3.5	1A	A	Medium stiff brown fat CLAY with sand (trace gravel, trace cobbles) - moist	3 3 5	8	
3.5–6.0	2A	A	Stiff brown sandy lean CLAY (trace gravel) - moist	4 5 6	11	
6.0–13.5	3A	A	Medium dense brown SAND - moist	5 6 5	11	
	4A	A	(Trace gravel at 8.5')	8 11 13	24	
13.5–15.0	5A	A	Medium dense brown SAND with gravel - moist	15 15 13	28	
15.0			Bottom of boring at 15.0 feet			

Depth scale: 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0

WATER LEVEL MEASUREMENTS

	DEPTH	DATE
INITIAL	NONE	3/19/2003
AT COMPLETION	NONE	3/19/2003
OTHER	N/A	N/A

A — SPLIT SPOON
B — ROCK CORE
C — SHELBY TUBE
D — SOIL PROBE
E — AUGER CUTTINGS
F — SONIC

4518 TAYLORSVILLE ROAD
PO BOX 51
DAYTON, OHIO 45424
PH 937.236.8805
FAX 937.233.2016
BOWSER MORNER®

CLIENT **SETTER, LEACH & LINDSTROM**	JOB NO. 127776	
PROJECT **SOIL STUDY FOR PROPOSED GOLF MAINTENANCE FACILITY AREA "A", WPAFB, OHIO**	BORING STARTED 3/19/03 BORING COMPLETED 3/19/03 DRILLER JA METHOD 3 1/4" HSA TYPED BY kmw	2 Boring No. Sheet 1 of 1

PROJECT LOCATION
LAT. 39° 48' 22" LONG. 84° 02' 46"
SURFACE ELEVATION 823.5'
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS

REMARKS

DEPTH	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.
0.0–0.5		TOPSOIL		
0.5–3.5	1A	Medium stiff brown fat CLAY with sand (trace gravel) - moist	3 3 4	7
3.5–6.0	2A	Medium stiff brown sandy lean CLAY (trace gravel, trace cobbles) - moist	3 4 4	8
6.0–13.0	3A	Medium dense brown SAND - moist	4 4 7	11
	4A	(Trace gravel at 8.5')	12 13 15	28
13.0–15.0	5A	Dense brown SAND with gravel (trace cobbles) - damp	15 22 21	43
15.0		Bottom of boring at 15.0 feet		

WATER LEVEL MEASUREMENTS

	DEPTH	DATE
INITIAL	NONE	3/19/2003
AT COMPLETION	NONE	3/19/2003
OTHER	N/A	N/A

A — SPLIT SPOON
B — ROCK CORE
C — SHELBY TUBE
D — SOIL PROBE
E — AUGER CUTTINGS
F — SONIC

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PO BOX 51
DAYTON, OHIO 45424
PH 937.236.8805
FAX 937.233.2016
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CLIENT	JOB NO.		
SETTER, LEACH & LINDSTROM	127776		3
PROJECT	BORING STARTED 3/19/03	BORING COMPLETED 3/19/03	Boring No.
SOIL STUDY FOR PROPOSED GOLF MAINTENANCE FACILITY AREA "A", WPAFB, OHIO	DRILLER JA	METHOD 3 1/4" HSA	
	TYPED BY kmw		Sheet 1 of 1

PROJECT LOCATION
LAT. 39° 48' 22" LONG. 84° 02' 46"
SURFACE ELEVATION 821.9'
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

DEPTH	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	COMMENTS	REMARKS
0.0–0.5					TOPSOIL				
0.5–3.5	1A				Medium stiff brown fat CLAY with sand (trace small roots) - moist	2 3 3	6		
3.5–6.0	2A				Stiff brown sandy lean CLAY (trace gravel) - moist	4 6 7	13		
6.0–13.5	3A				Medium dense brown SAND (trace gravel) -moist	4 5 8	13		
	4A					11 13 13	26		
13.5–15.0	5A				Dense brown SAND with gravel (trace cobbles) - damp	12 14 17	31		
15.0					Bottom of boring at 15.0 feet				

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	3/19/2003
AT COMPLETION	NONE	∇	3/19/2003
OTHER	N/A	▼	N/A

A — SPLIT SPOON
B — ROCK CORE
C — SHELBY TUBE
D — SOIL PROBE
E — AUGER CUTTINGS
F — SONIC

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PO BOX 51
DAYTON, OHIO 45424
PH 937.236.8805
FAX 937.233.2016
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CLIENT
SETTER, LEACH & LINDSTROM

PROJECT
SOIL STUDY FOR PROPOSED GOLF MAINTENANCE FACILITY AREA "A", WPAFB, OHIO

JOB NO.	127776		
BORING STARTED	3/19/03	BORING COMPLETED	3/19/03
DRILLER	JA	METHOD	3 1/4" HSA
TYPED BY	kmw		

Boring No. 4

Sheet 1 of 1

PROJECT LOCATION
LAT. 39° 48' 22" LONG. 84° 02' 46"

SURFACE ELEVATION 823.0

BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS

N VALUE, blows/ft.

DEPTH	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE	REMARKS
0.0–0.5		TOPSOIL			
0.5–3.5	1A	Medium stiff brown fat CLAY with sand (trace small roots) - moist	3, 4, 3	7	
3.5–8.5	2A	Medium stiff brown sandy lean CLAY (trace gravel) - moist	4, 5, 5	10	
	3A	(Becomes stiff at 6.0')	6, 7, 8	15	
8.5–13.5	4A	Medium dense brown SAND - moist	10, 10, 15	25	
13.5–15.0	5A	Dense brown SAND with gravel (trace cobbles) - damp	20, 23, 23	46	
15.0		Bottom of boring at 15.0 feet			

WATER LEVEL MEASUREMENTS

	DEPTH	DATE
INITIAL	NONE	3/19/2003
AT COMPLETION	NONE	3/19/2003
OTHER	N/A	N/A

A — SPLIT SPOON
B — ROCK CORE
C — SHELBY TUBE
D — SOIL PROBE
E — AUGER CUTTINGS
F — SONIC

4518 TAYLORSVILLE ROAD
PO BOX 51
DAYTON, OHIO 45424
PH 937.236.8805
FAX 937.233.2016
BOWSER MORNER

Atterberg Limits

ASTM (D-4318)

BOWSER MORNER.

Client: Setter, Leach & Lindstrom
Project: Golf Maintenance Facility

Work Order No.: 127776
Date: 03/27/03

Boring Number	Sample Number	Depth, (ft)	Depth, (m)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Moisture Content, (%)
2	1A	1.0 - 2.5	0.3 - 0.8	50	20	30	20.0

Moisture Content of Soil

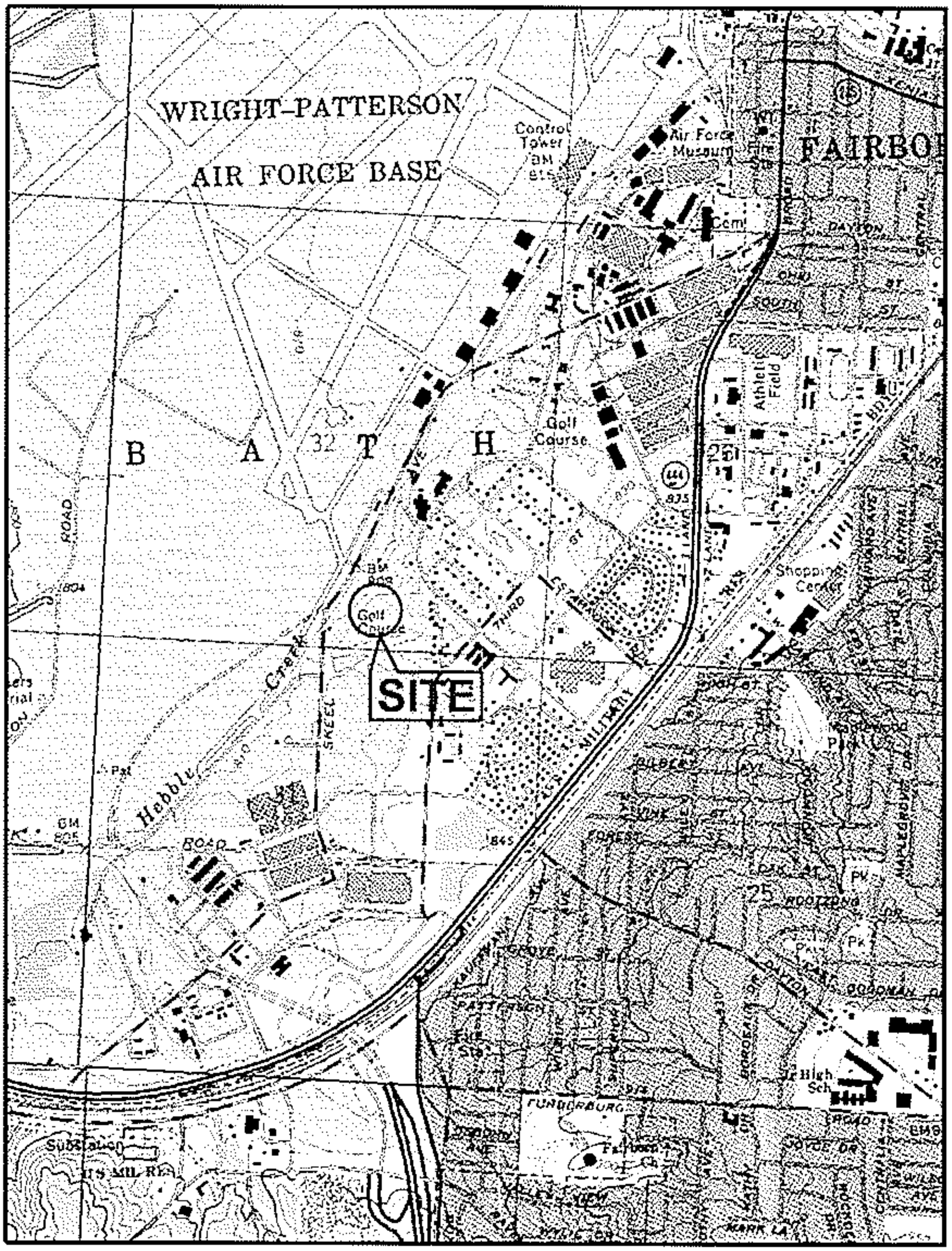
ASTM (D-2216)

BOWSER MORNER.

Client: Setter, Leach & Lindstrom
Project: Golf Maintenance Facility

Work Order No.: 127776
Date: 03/25/03

Boring Number	Sample Number	Depth, (ft)	Depth, (m)	Moisture Content, (%)
1	3 A	6.0 - 7.5	1.8 - 2.3	13.0
	4 A	8.5 - 10.0	2.6 - 3.0	7.0
	5 A	13.5 - 15.0	4.1 - 4.6	5.7
2	1 A	1.0 - 2.5	0.3 - 0.8	20.0
	3 A	6.0 - 7.5	1.8 - 2.3	9.9
	4 A	8.5 - 10.0	2.6 - 3.0	3.9
3	1 A	1.0 - 2.5	0.3 - 0.8	23.6
	2 A	3.5 - 5.0	1.1 - 1.5	11.5
	3 A	6.0 - 7.5	1.8 - 2.3	10.2
4	1 A	1.0 - 2.5	0.3 - 0.8	23.8
	2 A	3.5 - 5.0	1.1 - 1.5	12.2
	3 A	6.0 - 7.5	1.8 - 2.3	12.5
	4 A	8.5 - 10.0	2.6 - 3.0	16.5



USGS QUAD: FAIRBORN, OHIO

LATITUDE: 39°48'22" LONGITUDE: 84°02'46"

VICINITY MAP

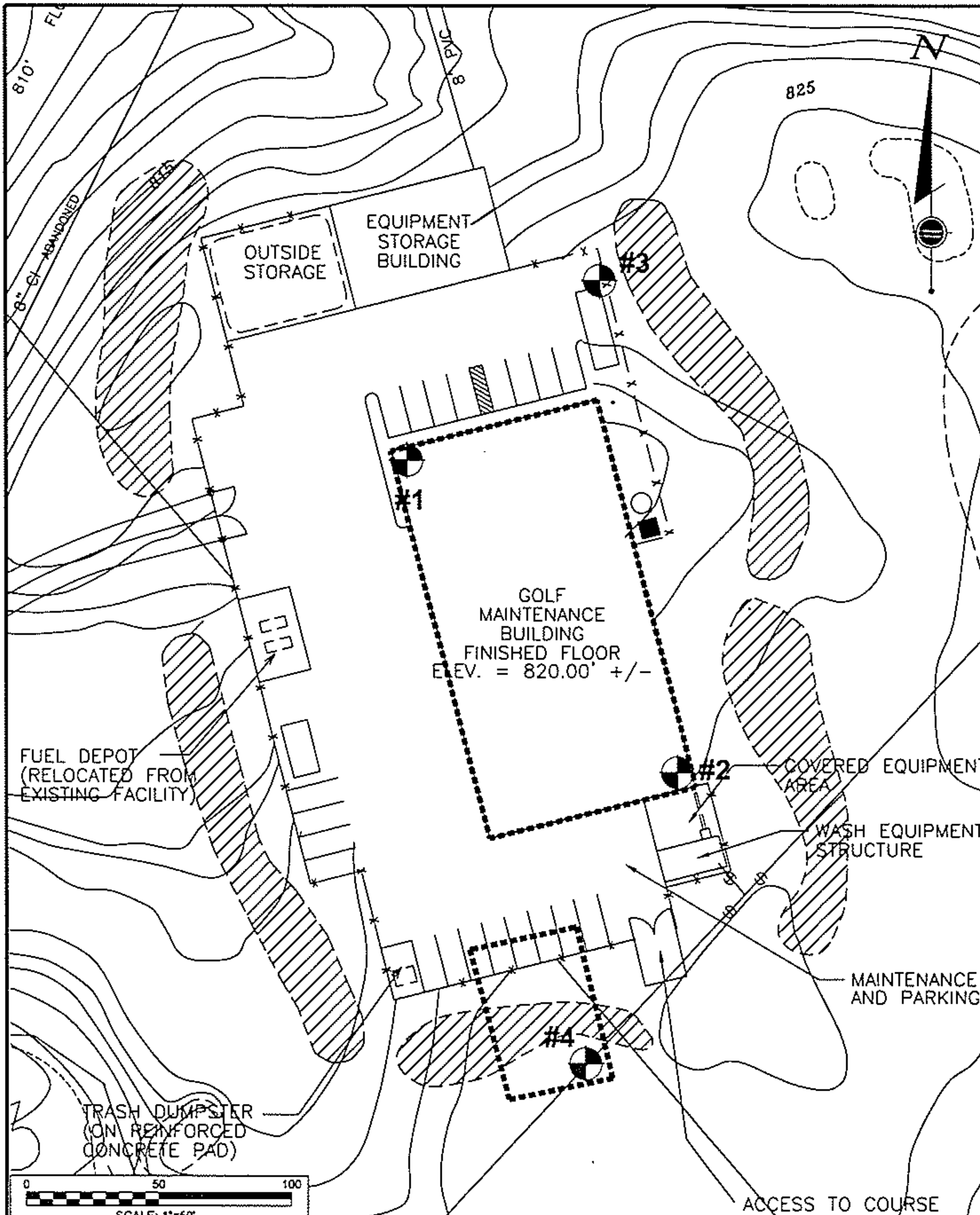
SOIL STUDY FOR PROPOSED
GOLF MAINTENANCE FACILITY
AREA A
WPAFB, OHIO

CLIENT: SETTER, LEACH, & LINDSTROM

03-03/HGW

PROJECT NO.	127776
SCALE	1"=2000'
FIGURE NO.	1

BOWSER MORNER.
4518 Taylorsville Road
Dayton, Ohio 45424
Ph 937-236-8805
Fax 937-233-2016



BORING LOCATION PLAN

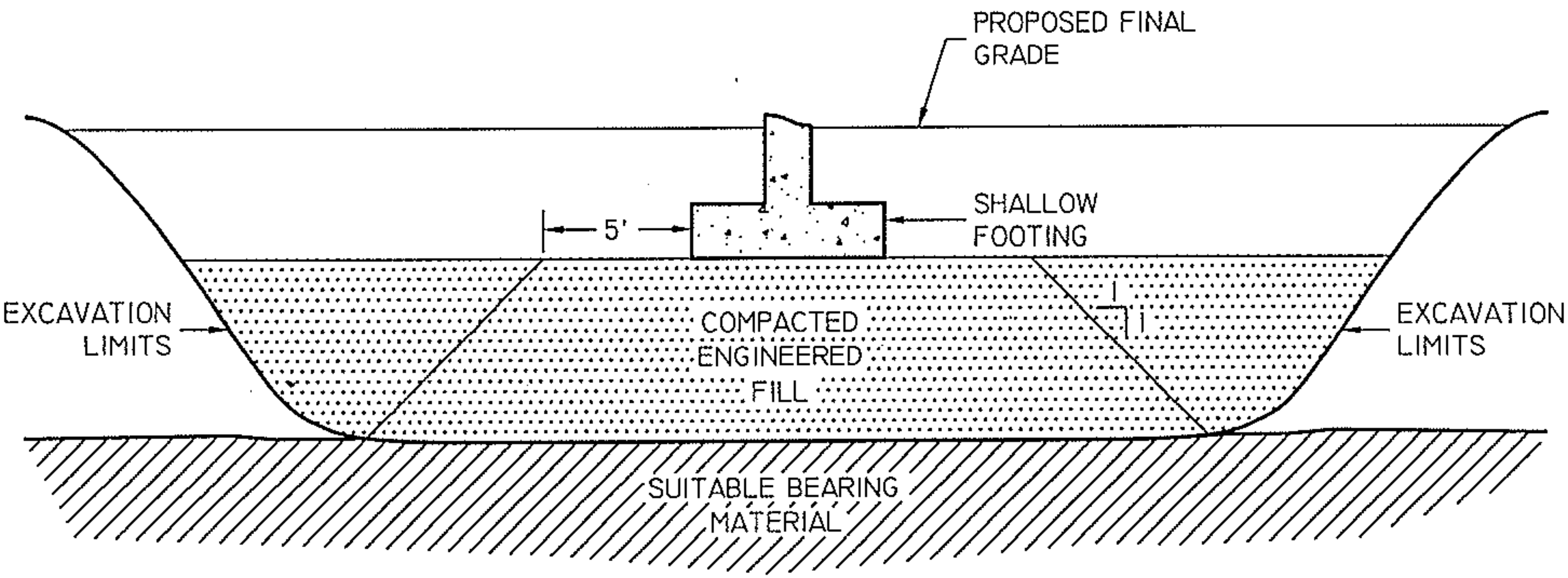
SOIL STUDY FOR PROPOSED
GOLF MAINTENANCE FACILITY
AREA A
WPAFB, OHIO

CLIENT: SETTER, LEACH, & LINDSTROM

03-03/HGW

PROJECT NO.	127776
SCALE	GRAPHIC
FIGURE NO.	2

BOWSER MORNER.
4518 Taylorsville Road
Dayton, Ohio 45424
Ph 937-236-8805
Fax 937-233-2016



DESIGN ILLUSTRATION EXCAVATION LIMITS FOR SHALLOW FOOTINGS 04/00	SCALE NONE FIGURE NO. 3	BOWSER MORNER®